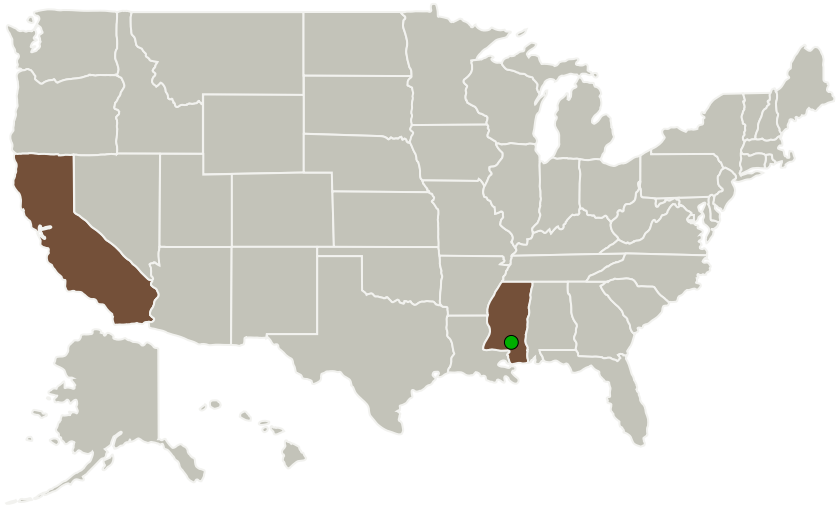
Fabrication and Testing of Nuclear-Thermal Propulsion Ground Test Hardware, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

Efficient nuclear-thermal propulsion requires heating a low molecular weight gas, typically hydrogen, to high temperature and expelling it through a nozzle. The higher the temperature and pressure, the higher the thrust and specific impulse. For ground test facilities that will be heating the gas to temperatures up to 4400 F (2425 C), the number of materials that can be used is severely limited. The need for compatibility with hot hydrogen limits the field even further. In this project, Ultramet will design, fabricate, and test a system for heating high-pressure hydrogen up to 2400 C. The system will comprise a resistively heated open-cell refractory carbide foam heating element and an oxide-lined rhenium tube to contain the heater. By passing an electric current through the foam ligaments, they can be heated to arbitrarily high temperatures, and the carbides are stable in hot hydrogen. In previous work, Ultramet has demonstrated the ability to make robust electrical connections to foam heaters that will tolerate high temperature operation. Unlike most other refractory metals, rhenium is both ductile and non-reactive with hydrogen. It is also very strong and creep-resistant at high temperature. Consequently, rhenium is the material of choice for the pressure vessel and other hydrogen-washed surfaces such as the convergent/divergent nozzle. In the immediate vicinity of the heater, a thin layer of zirconia or hafnia (both of which are compatible with rhenium up to their melting point) will be used to electrically insulate the rhenium from the foam heater.

Primary U.S. Work Locations and Key Partners



Fabrication and Testing of Nuclear-Thermal Propulsion Ground Test Hardware Project Image

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Organizations Performing Work	Role	Type	Location
Ultramet	Lead Organization	Industry	Pacoima, California
Stennis Space Center(SSC)	Supporting Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations	
California	Mississippi

Project Transitions

June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140732)*

Images

Project Image
Fabrication and Testing of Nuclear-Thermal Propulsion Ground Test Hardware Project Image *(https://techport.nasa.gov/image/133369)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Ultramet

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

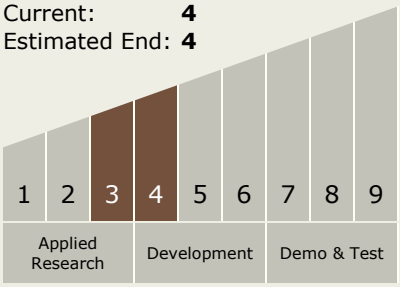
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Arthur J Fortini

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.3 Nuclear Thermal Propulsion

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System